Click Based Animation CAPTCHA

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Abstract: - Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) is a challenge-response test. CAPTCHAs are typically used by many websites to protect web form parameters against malicious input by verifying that the input is coming from a human and not from an automated program. Existing CAPTCHAs are mainly text-based on a static image and are known to be vulnerable to automated attacks. In this work, a Click based Animation CAPTCHA (CAC) is presented. CAC is designed to make it easy for people to solve CAPTCHA challenges. A small usability test was conducted to see how users respond to the proposed CAC. Results from the small usability evaluation show that CAC is a fun easy to use CAPTCHA. CAC was compared with a classical text based CAPTCHA. Results show that when moderate animation is employed, the proposed scheme achieves a higher accuracy rate than that of the classical text based CAPTCHA. Further directions of research are also discussed.

Key-Words: - CAPTCHA, Animation CAPTCHA, Usability, CAPTCHA Types, Evaluation.

1 Introduction

The ability to distinguish computers from humans is critical for the security of websites. Websites should constantly seek methods that prevent malicious computer programs from signing up for thousands of accounts or posting hundreds of comments on social media networking sites. For example, e-commerce websites like eBay need to prevent automated computer programs from overwhelming their site with scams. Email services like Gmail need to guard their email systems from the abuse of automated spamming scripts. Social networking like Facebook need to protect their systems from the spread of fake profiles, fake comments, and fake likes [2].

CAPTCHAs can be used to help websites automatically distinguish computers from humans. A CAPTCHA is a challenge response test in the form of a visual test or puzzle. The CAPTCHA challenges are usually easy for humans to recognize yet hard for a computer to solve [9]. A variety of CAPTCHA schemes have been proposed and implemented. CAPTCHA schemes are usually based on hard, open artificial intelligence problems such as object identification, character recognition, frame ordering, orientation detection, and speech recognition [13]. Traditional, yet the most popular, CAPTCHA schemes are text-based consisting of a word or a random sequence of characters embedded in an image. Traditional CAPTCHA schemes are subject to different attacks because of their static nature [1]. More recent CAPTCHA schemes are motion-based. Motion-based CAPTCHAs employ the humans' perceptual abilities, which make it possible for them to resolve complex patterns in quickly changing scenes [18].

To avoid cases where CAPTCHA challenges are recorded, solved by humans, and then used for answering future challenges, CAPTCHA challenges should at any time differ significantly from each other. To make this possible, challenges should be randomly generated from an enormous store of distinct challenges [13].

In this work, CAC, a new animation-based CAPTCHA scheme is presented. Users interact with CAC using pointing devices (e.g. mouse). To evaluate the usability of the proposed CAPTCHA scheme, a usability testing was conducted on CAC. Results of the usability testing of CAC are compared to that of reCAPTCHA [17], a well-

known text-based CAPTCHA. Results show that with a moderate level of animation, CAC can achieve a higher accuracy rate when compared to that of reCAPTCHA. Furthermore, participants of the study reported a positive attitude toward the usability of CAC.

The rest of the paper is organised as follows: section 2 includes the related work, section 3 provides some details related to CAPTCHA usability, section 4 provides an overview of the proposed CAPTCHA, section 5 provides details on the usability study that was conducted, section 6 provides details of the results obtained from the study, section 7 includes a discussion of the results, and finally section 8 concludes this research.

2 Related work

A CAPTCHA is often considered as an automated security measure. Existing CAPTCHA schemas can be classified into five categories: text-based, image-based, audio-based, motion-based (also referred to as video and animation) and hybrid CAPTCHAs [13].

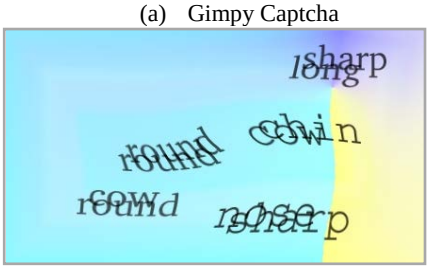
As previously mentioned, text-based CAPTCHAs consist of words or characters embedded in an image and presented to the user. Users are then required to recognise all the characters constituting the CAPTCHA and input them in order in the designated input box. The rendered image may contain distortions, making the characters present in the image difficult to be automatically recognised [13]. Figure 1-a and Figure 1-b show two examples of the two popular text-based CAPTCHAs, developed by Carnegie Mellon University, Gimpy and EZ-Gimpy. In the original CAPTCHA, Gimpy, seven words are shown from which have to be recognized by the human user. Later on this was simplified with the introduction of the EZ-Gimpy, shown in Figure1-b. The EZ-Gimpy, unlike the traditional Gimpy, consists of only one word to be recognized. Figure 1-c shows an example of reCAPTCHA [17], another example of an important text-based CAPTCHA.

In general, adding noise and distortion enhances the security of text-based CAPTCHAs at the price of compromising their usability [13]. Many techniques have been proposed in literature that allow the breaking of text-based CAPTCHAs [6][19][20]. Image-based CAPTCHAs exploit the humans' ability to easily identify an object in an image. An image-based CAPTCHA is in essence, an image that is displayed to the users. Users are then asked a question related to the contents of the image. Figure 2-a and Figure 2-b show two examples of image-based CAPTCHAs, namely SweetCaptcha [16] and Asirra [3]. Collage CAPTCHA[14] is also an example of image-based CAPTCHAs. Compared to text-based CAPTCHAs, image-based CAPTCHAs are more usable, but require a larger storage space.

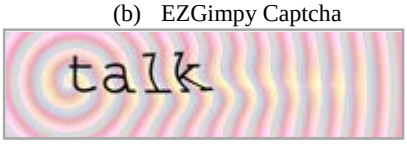
An audio CAPTCHA uses a random sequence of characters, renders them into a sound clip, adds some distortion, and then presents the resulting clip to the users. Typically, users are required to recognize all the characters constituting the CAPTCHA and input them in order in the designated input box. Audio-based CAPTCHAs are usually used as a supplement to text-based CAPTCHAs. However, from usability perspective, this type of CAPTCHA is more problematic than other types [3].

Fig. 1: different kinds of text-based CAPTCHA

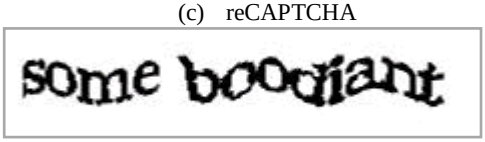
(a) Gimpy Captcha



(b) EZGimpy Captcha



(c) reCAPTCHA

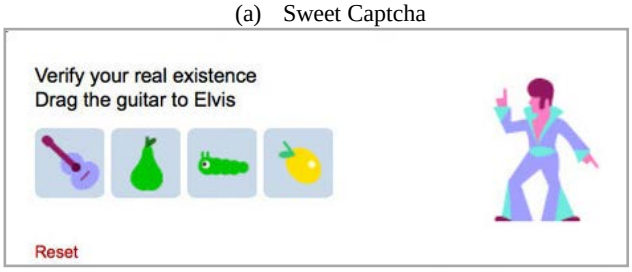


Motion or video-based CAPTCHAs provide some form of motion based challenges. Typically, users are asked to recognize an action, animated word or image shown in the motion-based CAPTCHA. Motion based CAPTCHAs are considered more secure than text and image-based CAPTCHAs. This can be attributed to the fact that automated techniques often fail when attempting to solve these motion-based challenges. Yet, these challenges can be solved by humans with minimal effect. Hence, motion-based CAPTCHAs can be considered as the most secure and usable type of CAPTCHA. Disadvantages of motion-based CAPTCHAs when compared to text or image-based CAPTCHAs include: (1) database size: a significantly larger database is required to store the motion-based CAPTCHAs and (2) loading time: more time is needed to load the motion-based CAPTCHAs [3]. The proposed CAPTCHA (CAC) belongs to this category. Details on CAC are discussed in the

subsequent sections. In the rest of this section, details on related motion-based CAPTCHAs are provided.

Fig. 2: different kinds of Image-based CAPTCHA

(a) Sweet Captcha



(b) Asirra Captcha

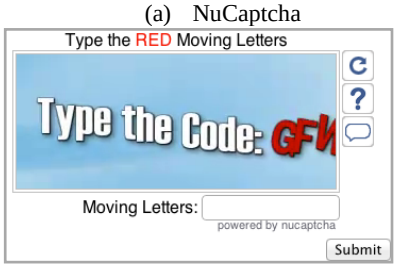
Figure 3-a shows an example of NuCaptcha [11], where an English letter string is animated from right to left. Users are asked to type in the last word. On NuCaptcha's blog, the company states that NuCAPTCHA achieved in a user experience study a success rate of 99 percent. It is worth mentioning that the study was conducted with only three participants.

Figure 3-b is an example of Hellocaptcha [5], in which a sequence of six letters or digits is displayed as an animated GIF image. Users are required to input the characters in the correct sequence [13]. To the authors' knowledge, no usability test has been conducted on HelloCaptcha.

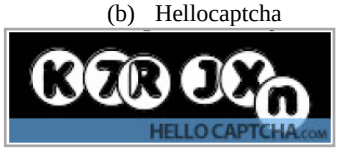
Figure 3-c is an example of Animation captcha [15], in which a few randomly moving animated objects are presented to the users. Users are required to detect and click on one of the objects [13]. The authors argue that the random nature of Animation Captcha makes it more secure against random guessing or segmentation attacks [13] [1]. Java applets are used to the display animated objects. Client side validation of user response is used, where the answer of each CAPTCHA challenge is encrypted and embedded inside the applet. The authors' main focus when developing Animation Captcha was on its security so a usability test was not conducted [1].

Fig. 3: Other examples of CAPTCHA

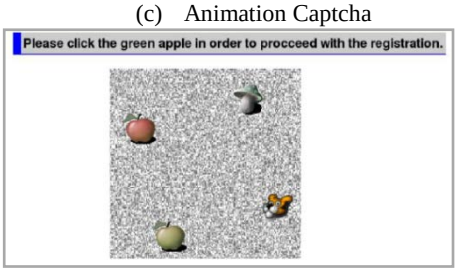
(a) NuCaptcha



(b) Hellocaptcha



(c) Animation Captcha



Dynamic CAPTCHA [14] and Multiple Challenge Response System [10] are examples of hybrid CAPTCHAs that combine two or more of the techniques described above.

3 CAPTCH Usability

Usability refers to how well a product or system performs the desired tasks easily and effectively. Yan and El Ahmad [21] identified three criteria for assessing the usability of CAPTCHAs: (1) content (what is being presented), (2) distortion (how the content has been modified) and (3) presentation (how the content is presented). Text-based CAPTCHAs pose more and more usability challenges [2] and they are, generally, language dependent. In different CAPTCHA systems, including motion-based CAPTCHAs, users are asked to enter their answers by different methods such as typing the answer, selecting from a drop-down list, clicking the answer; or dragging and dropping answers to boxes. While the most common method is typing, mouse interaction methods are more usable since they simplify and accelerate the answering process [13].

This work is an attempt to create a semi language independent usable motion based CAPTCHA that employs the mouse instead of the keyboard for user

input. Moreover, for security reasons, the verification of users' responses is performed at the server side and not on the client side. This work is inspired by the hypotheses from NuCAPTCHA, pertaining to mouse interactions that can enhance the CAPTCHA's usability, and by the fresh, user friendly nature of SweetCAPTCHA [16].

4 CAC Description

4.1 Overview

The proposed prototype CAC is a motion-based CAPTCHA, comprising of a video of animated funny objects on a plain light background. To pass the CAC challenge, the user must click with the mouse on a specified, moving object(s) inside the video. The instruction,"click on the smiley face", is an example of the CAC challenge.

4.2 Implementation

CAC uses the traditional client-server model. Adobe flash is used to deliver the client-side animation. When a user requests a page that uses CAC, a server side generated challenge is presented to the user, with instructions to click on a particular coloured, funny face. When the user clicks anywhere inside the movie area, the time and position of the click, relative to the video starting time, is recorded and sent to the back-end for verification. For each challenge, only the first click is accepted. Server side code then runs to determine for a particular challenge, whether the user has clicked on the correct challenge response object or not. If the user clicked on the required object, the challenge is considered correctly solved; otherwise, a new challenge is presented to the user.

In this work, a static set of videos was generated for testing purpose. Creating a framework for dynamically generating videos is considered out of scope of the current research and may be addressed in a future work.

4.3 Usability Related Objectives and Decisions

The data entry methods of responses to CAPTCHA challenges vary from one system to another. These methods include: typing the answer in an input box, selecting the correct option from a drop-down list, clicking on the answer; or dragging and dropping answers to boxes. While the most common method of answering a CATCHA challenge is typing the response in an input box, mouse interaction methods are more usable since they simplify and accelerate the answering process [13]. To support this notion, additional studies have shown that clicking is the fastest entry method [8].

CAC employs funny objects in its video challenge. While the choice of funny objects is neither related to the system's technological requirements nor to its security requirements, the authors believe that the use of such objects can be useful from a usability perspective. To avoid user confusion, the funny objects move in a smooth motion from left to right with a slight variation in the vertical position. The use of other random and uniform motion paths is considered as future work.

Because foreground objects can be extracted from background images, the use of distorted backgrounds can be confusing without necessarily being secure [20]. Hence, in CAC the objects are presented on a simple background.

When compared to NuCAPTCHA [11] (shown in Figure 6) and HelloCAPTCHA [5] (shown in Figure 7), CAC can be considered easier, mainly because users can respond to challenges using pointing devices. Furthermore, CAC is less dependent on natural language, and therefore may be easier for localization in other languages. Moreover, a main difference between CAC and Animation Captcha [1] (shown in Figure 8) lies in their different main focus. While the primary focus of Animation Captcha is its security, the main focus of CAC is its usability. Hence, the usability of Animation CAPTCHA [1] has not been tested. The authors of this research strive to create for CAC users a positive user experience, and hence will examine this by conducting a usability test.

When compared to SweetCAPTCHA [16] (shown in Figure 4), the main difference is related to the challenge response entry method utilised. Whilst, SweetCAPTCHA utilises a drop and drag technique, CAC employs a simple a simple point and click technique. The authors believe that a point and click approach is more user friendly than a drop and drag approach as it has been found to be the quickest input method, whilst dragging is the slowest input method [8].

One of limitations, common between the proposed scheme and other video and image CAPTCHAs, is that these challenges can be difficult and not suitable for users with visual difficulties.

4.4 Security Related Objectives and Decisions

Although CAC's usability is the primary objective of this study; never the less; some security related decisions have been made.

Even though the movement of objects displayed on the CAC CAPTCHA is uniform, some motion randomness has been added. The added randomness is small enough to be unrecognized by users, but the authors believe that this randomness will help make object auto recognition harder. Even though security optimization of CAPTCHAs is not the main objective of this work, the authors believe that the use of the time dimension enhances the security of CAC compared to other CAPTCHAs that depend on static images.

Since objects continually move, a particular set of pixels forms the answer of the challenge only at a particular point in time. Server side verification should be used in order to validate users' responses.

Although, CAC's security is outside the scope of this paper, the authors acknowledge that an object recognition algorithm, like the one that is described in [18], can break this CAPTCHA. To address this problem in the future, the authors propose the use of emerging images as described in [18].

5 Usability Study

An online user study was conducted between the period of 5 December 2014 and 8 December 2014 to find out how users respond to the proposed prototype. Online studies facilitate data collection from more participants. Snowball sampling was used to enable a larger number of participants. Contact was initiated through email and social media notices passed on through personal contacts or acquaintances. The main purpose behind the study was to evaluate ease-of-use and to identify any usability problems that might arise. To get an indication of how the prototype performs in comparison to a classical text based CAPTCHA, participants were presented with two sets of CAPTCHAs. The first set contains sample from reCAPTCHA's text-based CAPTCHA challenges. The second set contains challenges of the proposed CAPTCHA, CAC.

The usability study described here has been reviewed and approved by the Carleton University Research Ethics Board. Participants were notified that they are taking part of a study about using CAPTCHAs in websites. Then they were provided with a demographics questionnaire before actually performing a real CAPTCHA study followed by a user preferences questionnaire. A pilot study of the usability study was conducted prior the actual usability study. The purpose of the pilot study was to avoid problems such as missing questions and improper response harvesting. Minor typing errors were found and corrected.

5.1 Participants, Demographics, and Familiarity with CAPTCHAs

Participants were recruited using the social network of the main author (i.e. relatives, friends, and friends of friends). Participants can skip any question if they want, and may exit the study at any time. A total of 49 adult participants were contacted, out of which 33 completed the study. Out of the 33, 7 participants did not have a proper player for flash animation. In this study, the authors report the results from the 26 participants who completed the study and could play the animated CAPTCHAs. Out of the 26 participants, 11 participants reported their age. About half of them (5 participants) were between 21 and 30 years old, whilst the remaining were between 30 and 40 years old. In relation to the participants' educational level, all participants who reported educational level had at least a university bachelor degree.

Regarding the frequency of using websites, all participants except one, reported that they use the World Wide Web (WWW) daily. This one participant reported using the WWW several times a week.

Regarding familiarity with CAPTCHAs, The majority (15 participants) reported they have encountered CAPTCHAs before this study (8 of them reported they visit websites that require solving CAPTCHAs several times a week, 3 reported once a week and 4 reported less than once a week). However, 10 participants reported they haven't encountered CAPTCHAs before this study.

5.2 User Preferences Survey

A user preferences online survey was conducted to study if there is any correlation between the user's perceived difficulty, the time needed to solve the challenge, and the accuracy of the response. Participants were asked to rate a total of items related to their preferences on a 10 point likert scale with 1 equal to 'strongly disagree' and 10 equal to 'strongly agree'. The survey also included two open-ended questions which allowed participants to describe freely what they like and dislike about the prototype. The nine questions of users' preferences survey are presented in Table 1. Questions 2 through 9 were related to the new proposed CAPTCHA, CAC.Table 1Users' Preference Questions.

Table 1: Users' Preference Questions

Question Number	Question Text
Question 1	Based on my experience, it was easy to solve the traditional text-based CAPTCHAs that I normally encounter on the web
Question 2	It was easy to accurately solve the challenges.
Question 3	The challenges were easy to understand.
Question 4	This CAPTCHA mechanism was pleasant to use
Question 5	I found it hard to solve challenges presented on this CAPTCHA scheme.
Question 6	I found this mechanism well suited for the websites
Question 7	On websites, I would prefer using this CAPTCHA mechanism compared to other CAPTCHAs.
Question 8	This CAPTCHA mechanism is more prone to mistakes than traditional text-based CAPTCHAs
Question 9	This type of CAPTCHA would be easy for attackers to break

5.3 Tasks

A typical session consisted of the following:

1. Complete project information which was made available online. Accessing the survey and submitting responses were considered consent to participate
2. A web page clearly stating that the purpose of this study is not to test the participants' performance in answering the challenges, but to test the effectiveness of the prototype and uncover its strengths and weaknesses.
3. Each participant was asked to solve two sets of ten challenges. The first set of challenges are those of reCAPTCHA, a popular text based scheme, while the second set are those of CAC, the proposed motion-based prototype.
4. Each participant was asked to complete a questionnaire about the participant's opinion and perception towards the two prototypes.
5. The session concluded with an online thank you message.

A static set of ten reCAPTCHA challenges was collected from two sources. Five challenges were easy and are courtesy of [12]. Figure 4 is an example of an easy challenge. The other five challenges were more challenging and are courtesy of [4].

Fig. 4: Easy reCAPTCHA

As for the CAC challenges, four challenges were of "normal" difficulty. Each included 5 different objects; the animation was presented as 12 frames per second with overlapping between objects. Different objects were targeted in different challenges. Figure 5-a is an example of a CAC challenge with "normal" difficulty, in which participants were asked to click on the baby image. These challenges will be referred to as moderate animation variant.

To get a better understanding of the effect of increasing the movement speed of objects, two other challenges were displayed at higher frame rate; one with 24 frames per second and the other with 48 frames per second. Both challenges have 5 non overlapping objects. These challenges will be referred to as double and quad speed variants respectively.

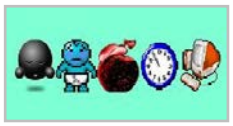
To help understand the effect of overlapping distortion on usability, two other challenges were displayed. The challenges contain overlapping objects; one with 25 percent of object width overlapping as shown in Figure 5-b and the other with 50 percent of object width overlapping as shown in Figure 5-c . Both challenges consisted of 5 objects moving at normal speed. These challenges will be referred to as small and large overlap variants respectively.

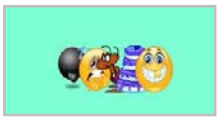
The last two challenges contained different number of objects; one with 10 objects as shown in Figure 5-d and the other with 3 objects as shown in Figure 5-e. In both challenges, the objects were non-overlapping and moving at normal speed. These challenges will be referred to as small number of objects and large number of objects variants respectively.

The set of text based CAPTCHA challenges was presented in a random order before randomly presenting the CAC challenges.

Fig. 5: Click based Animation CAPTCHA (CAC)
(a) Moderate Animation CAC. (b) Animation

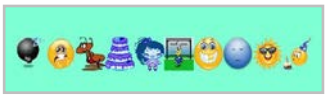
CAPTCHA with 25%object overlapping.



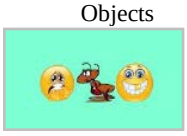


(c) Animation CAPTCHA with 50% object overlapping.

(d) Animation CAPTCHA with ten objects.



(e) Animation CAPTCHA with 3 Objects



5.4 Environment Setup

A web application was used to gather users' responses to both CAC and reCAPTCHA challenges. At a later point, the users' responses were validated off line. A static set of ten click-based animated CAPTCHA challenges was prepared and presented randomly to users. Another static set of ten reCAPTCHA challenges, with different distortions, was used. Each challenge was presented once to each user; only first response was taken into account.

Each set of challenges was presented on single webpage. In the reCAPTCHA challenges page, each challenge has a designated text field for the users to enter their answers. The images of reCAPTCHA challenges were approximately 300 x 50 pixels. The frame size for CAC was 800 x 300 pixels. All images embedded in the animation were scaled to 50 x 50 pixels.

Javascript was used to record users' responses to the CAC challenges. The response values were in the horizontal and vertical mouse coordinates of the first mouse click on the CAPTCHA, in addition to the time elapsed from the moment the animation was loaded until the moment the participant clicked anywhere on the frame. This is important for validating participants' answers, since recording the positions of clicks alone is not sufficient to verify challenges' answers as target images are changing positions over time. Participants were asked to click on a link to load a CAC's challenge. The link was accessible only once per CAC challenge.

To prevent auto responding, a simple CAPTCHA was used as a protection mechanism. To avoid multiple responses of the same user, the LimeSurvey was configured to use local caching. For each response in the study, an email was received form LimeSurvey. No automated response was conducted.

5.5 Limitations

Although the conducted user study has resulted in some preliminary findings, its design has a few shortcomings. Hence, a number of limitations related to the user study need to be noted. The first limitation concerns participant observation. As mentioned earlier, an internet based data collection method was employed in this study to help recruit a larger number of participants. Hence, the authors were not able to observe the participants in their study. The second limitation concerns the sample size. A sample size of 26 participants who successfully completed the user study cannot be considered representative of all CAPTCHA users.

Survey length refers to the amount of time a respondent needs to complete the survey. This length is very important because it has a direct affect on response rates and data quality. The longer the survey is the lower the response rates and qualities of responses are [7]. Hence, the third limitation concerns the survey length. The survey included 20 challenges in total. The authors believe that the addition of more challenges (with different types of distortions) will affect the response rates and quality of responses. Finally, due to time constraints, no usability comparison was conducted with the related works such as [11], [5] or [1]. This comparison is left as future work.

6 Results

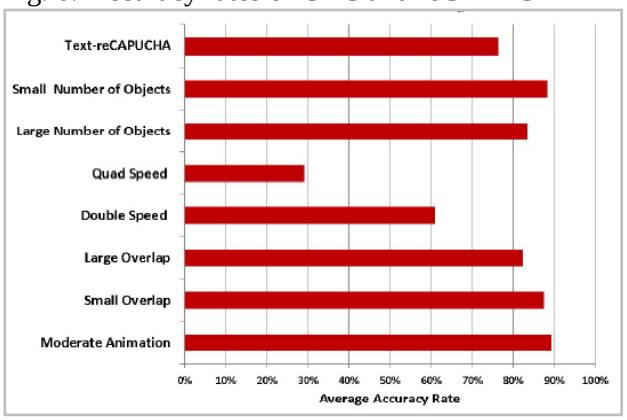
This section summarises the results obtained from the user study. A discussion of these results is provided in the next section.

6.1 Accuracy Results

Only one attempt was given to each participant to solve each CAPTCHA challenge. Figure 6 summarises the accuracy rates for CAC variants, and reCAPTCHA challenges. Results shown in the figure indicate that the highest accuracy rate is achieved with the moderate animation variant of CAC. Most other variants of CAC achieved better accuracy than reCAPTCHA. As expected, increasing the speed of the animation, results in

lower accuracy rates. Surprisingly, doubling the overlap percentage does not have a large effect on the accuracy rate. Furthermore, the number of objects, whether small or large number, have very little effect on the accuracy rate.

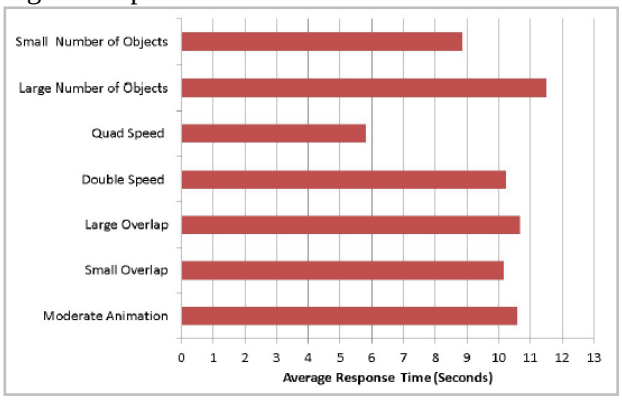
Fig. 6: Accuracy rates of CAC and reCAPTCHA



6.2 Response Time

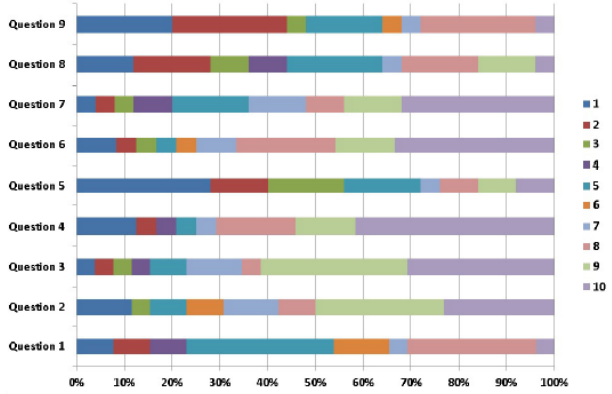
For technical reasons, response time was calculated for the new CAPTCHA challenges only, and not for the text based CAPTCHA challenges. Figure 7 summarises the users' response times for the proposed CAPTCHA. As shown, the shortest response time was achieved with the highest speed of animation, and the longest response time was that of the CAPTCHAs with a large number of objects. Surprisingly, challenges with small overlap, have a slightly shorter response time compared to regular challenges. Using a smaller number of objects resulted in a shorter response time compared to regular challenges.

Fig. 7: Response Time



However, it worth noting that the success rate of using high quad speed is less than that of the moderate animation variant's challenges as shown in the previous subsection. This implies that users were responding quicker but with inaccurate responses to quad speed challenge.

Fig. 8: Users' Preferences



6.2 Users' Preferences

Figure 8 summarises the participants' preferences. The questions themselves are presented in Table 1. Overall, participants had a more positive attitude towards the new Click Based Animation CAPTCHA than towards the text based CAPTCHA. Participants found the new approach easier than the text based alternative. Furthermore, participants expressed a positive attitude towards most of the usability features of the proposed scheme. Participants found CAC pleasant, easy to understand, preferred, and well suited for use in websites. Participants' expressed a neutral response towards the security features of the proposed scheme.

In relation to the open ended questions, participants provided some positive such feedback such as: "I enjoyed the animations. They were very nice", "Yes, I enjoyed the CAPTCHA with the animated faces more than the letters and numbers", "I like it more than text-based CAPTCHA" and "Easy and interesting".

Responses to the open ended question also included some negative feedback such as: "some of the image-based CAPTCHA were very slow. I also suggest if more images are included in the CAPTCHA", "there should be more options in the faces (in future), and the motion should be quicker", "it is easy and fun. But I won't prefer using it all the time especially when I'm in hurry. It would be great if websites provide both options and leave the choice to us."

7 Discussion

The nature of the study didn't allow the authors to get immediate direct feedback from the participants. Yet, the open ended questions at the end of the survey provided the authors with a feel of how

participants individually perceived the system. It should be noted that words like ”fun” and ”interesting” were common in the responses.

The authors believe that the decision to make objects enter the display area from left to right instead of being displayed inside the frame at the very beginning of the animation movie, coupled with the fact the number of objects is not known, did, actually, increase response time. However, the authors believe that average response time of the regular variant of the proposed scheme is comparable to the time needed to recognize and type some text.

The authors argue that increasing the overlapping percentage of objects, makes it difficult for participants to recognize objects and, hence, delays their responses. A smaller overlapping percentage, on the other hand, speeds response time, simply because it reduces the time required by all objects to be displayed to participants. For the same reason, speeding up the animation, as well as reducing the number of objects, can improve response time.

Unfortunately, the delay in response time due to an increase in the speed of motion or a decrease in the overlapping percentage comes at the price of accuracy. This is consistent with the usability studies of CAPTCHAs in literature that confirm that increasing the distortion reduces the accuracy rate [18]. Moreover, the use of a large number of objects reduces accuracy rate. This may be caused by the fact that displaying ten objects requires a longer time. This time can be considered by some as unacceptable resulting in the participants losing interest in completing the challenge.

An accuracy rate of approximately 90 percent for moderate animation variant is encouraging, taking into consideration that no training of any kind was conducted, and no tutorial of any type was displayed. The new scheme was, somehow, different experience for participants especially those with non-computer related backgrounds.

8 Conclusion and Duture Work

In this work, CAC, a new CAPTCHA scheme using animations of “funny” objectswas presented. A usability testing for using some variants of CAC was conducted. In addition, the accuracy rate of CAC was compared to that of reCAPTCHA, a classical text based CAPTCHA. Results show that when using moderate animation variant, CAC achieves a higher accuracy rate compared to reCAPTCHA. Furthermore, speeding up the animation and increasing the overlapping percentage have a negative effect on accuracy rates, despite its positive effect on response time.

Future work could include:

- Comparing the usability of the proposed scheme with that of other motion-based CAPTCHAs using a large-scale usability study and through a field study.
- Evaluating the effect of using different motion paths, both regular paths, such as circular and rectangular, as well as irregular paths
- Developing a version appropriate for use in mobile devices especially smart phones

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